(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 409 443 A2**

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number: **90307258.5**

(51) Int. Cl.[5]: **A24D 3/02**, A24C 5/34

(22) Date of filing: **03.07.90**

(30) Priority: **20.07.89 GB 8916589**

(43) Date of publication of application:
23.01.91 Bulletin 91/04

(84) Designated Contracting States:
AT BE CH DE DK ES FR GB GR IT LI NL SE

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(54) **Control process and apparatus for the production of cigarette filters.**

(57) To improve quality control a cigarette filter manufacturing line is provided with a testing station (28) which periodically removes a filter to test the diameter (at 34) and resistance to draw (at 33). The mean diameter and RTD of a number of filters is calculated (at 36) and compared to acceptable ranges. Adjustments are made to the manufacturing line to correct any unacceptable values according to a set of priorities dependent on the degree and sense of the inaccuracies.

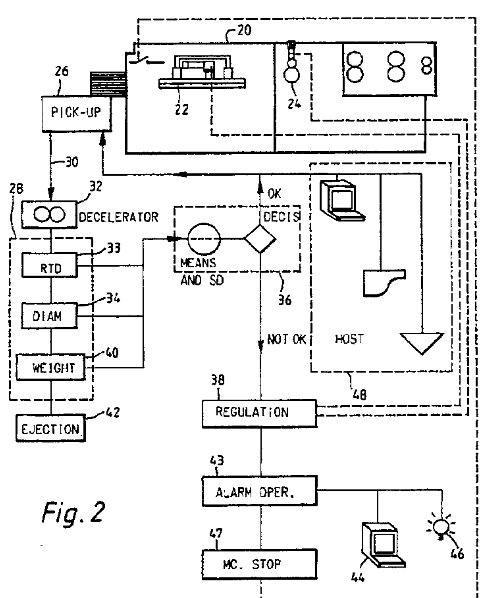

Fig. 2

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CONTROL PROCESS AND APPARATUS FOR THE PRODUCTION OF CIGARETTE FILTERS

This invention relates to the control of the manufacture of cigarette filters to optimise production quality.

One known quality control system for cigarette filter manufacture is sold under the trade mark QUARTET by Filtrona Instruments and Automation Limited. This system provides an automated statistical analysis of current quality trends which enables a machine operator to take whatever corrective action is deemed necessary. The system operates by picking up filters from the production line, measuring a number of filter parameters for each filter, displaying the measured parameters and developing a statistical analysis of the filter parameters. The system has a disadvantage in that it leaves the corrective action necessary to the machine controller to determine and implement. This is both slow and prone to inaccuracies.

The present invention aims to overcome these disadvantages and provides a method of controlling the manufacture of cigarette filters, comprising periodically removing a completed filter from a production line, and characterised by measuring at least two variable parameters of the filter, comparing each of the measured parameters with a respective predetermined target, and adjusting the operating conditions affecting at least one parameter in response to the comparison, if one or both are outside their respective targets, in accordance with a predetermined set of priorities dependent upon which parameter is outside the target and the degree and sense of each excursion from the target.

Preferably the target for each parameter is a range of acceptable values around a target value and the adjustment of the operating conditions causes one of the parameters to move just into the acceptable range.

The invention also provides apparatus for controlling the manufacture of cigarette filters, comprising means for periodically removing for testing a filter from the production line, and characterised by means for measuring at least two variable parameters of the filter, means for comparing each of the measured parameters with respective predetermined targets, and means for adjusting at least one parameter if one or more comparisons are not acceptable in accordance with a predetermined set of priorities dependent upon which parameter is outside its target and the degree and sense of each excursion from the target.

Preferably the apparatus includes means for adjusting each parameter to a value just within a range of values around the target value.

The system embodying the invention has the advantage of providing feedback control of the process. Furthermore, the adjustments made to the filter parameters depend on how far the parameter is from the target value and whether it is below or above the target value.

In a preferred embodiment the diameter and the RTD are the variable parameters. The diameter is always corrected in preference to the RTD unless the diameter only is acceptable or both parameters fall below their targets. If both are outside the target and one parameter falls within a second range of excursions then both parameters are corrected and an alarm signal is generated. If either parameter falls within a third excursion range the machine is stopped.

The invention also provides apparatus for conveying cigarette filters from a production line to a remote location, comprising a shuttle, a hopper arranged to receive a filter from a drum reservoir holding filters from the production line, and to guide the filter to the shuttle, means for rotating the shuttle between a first position in which it can receive filters from the reservoir, and as second position in which a received filter can be ejected by compressed gas to a tube for delivery to the remote location, characterised in that the filters in the second position being orthogonal to the filters in the reservoir.

The invention also provides apparatus for measuring the resistance to draw of a cigarette filter, characterised by a gauging head having a gas inlet and a gas outlet, means for receiving a filter arranged within the gauging head and having corresponding apertures for inlet and outlet of gas allowing passage of gas across a filter inserted in the receiving means, and a base portion having a port communicating with the receiving means for the passage of gas into the receiving means to assist the ejection of filters from the receiving means, and means for inverting the gauging head and receiving means for filter ejection.

A preferred embodiment of the invention wil now be described with reference to the accompanying drawings in which:

Figure 1 is a sketch of the process for manufacture of cigarette filters;

Figure 2 is a block diagram of the control apparatus of the invention;

Figures 3 and 4 show a filter pick-up device embodying a second aspect of the invention;

Figures 5 and 6 show, schematically, an RTD gauging head embodying a further aspected of the invention; and

Figure 7 is an exploded view of the gauging head of Figures 5 and 6.

Referring to Figure 1, tow is drawn from a bale 1 through banding jets 2 and pre-tension rollers 3 by drawing rollers 4. The tow is then drawn through a plasticizer spray booth 5 and delivery rollers towards a garniture belt 7. A wrapper 9 is fed from a roll 11 onto the belt 7 and the tow is laid down on the paper. Part way along the belt the tow and paper are shaped by curved side walls 12 and pressure is applied (at 13) to produce a tubular filter having a wrapper around its outer surface. The length of filter is cut at 15 and the filter lengths are conveyed away to a reservoir.

Referring now to Figure 2, there are two parameters of the filter which are measured and controlled, the filter diameter D and the 'Resistance to draw' RTD. The latter parameter is a measure of resistance of the filter to air and is dependant on how tightly packed the filter tow is. Although other factors such as the amount of plasticizer used are important they do not need a continuous automatic control.

In Figure 2 the filter production line is shown schematically at 20 and basically comprises a diameter control 22 and an RTD control 24. The diameter control comprises an automatically controlled servomotor which raises or lowers the upper garniture bar on the garniture belt and the RTD control comprises a motor control for increasing or decreasing the ratio between the speed of the two delivery rollers and the speed of the garniture belt. The adjustments made to both the delivery roller speed and the upper garniture bar are proportional to the deviation of diameter or RTD from prescribed limits.

Filters to be tested are taken off the production line by pick-up unit 26 which will be described in greater detail in due course. A filter rod is sent pneumatically from the pick-up unit 26 to a measurement station 28 through a pipeline 30. Prior to the measurement station the rod is retarded in a decelerator 32. The decelerator comprises a pair of rollers rotating with equal and opposite angular velocities, filters from the line 30 pass between the rollers and are expelled at a constant speed determined by the rotation speed of the rollers. In the measurement station the RTD is measured in an RTD gauge head 33 and the filter rod then drops into a tape gauge 34 where the diameter is measured. The tape gauge 34 is a standard type and is well known in the art. After the diameter has been measured the rod drops into a scale. After each RTD and diameter measurement the result is transmitted to the system controller 36. At approximately 20 second intervals further rods are introduced into the measurement station. After the system controller has received 5 RTD and diameter measurements, mean and standard deviation values for the two parameters are calculated and displayed on a screen. In addition the individual values of RTD and diameter are displayed as they are received.

If the means values are within prescribed limits then no action is taken and testing continues with the samne machine parameters. If the mean values fall outside the prescribed limits remedial action is taken at 38 to adjust the delivery roller speed and/or the upper garniture driving motor speed. The nature of the remedial action taken depends on the severity of the deviations from the prescribed limits and operates according to a predetermined hierarchical system of priorities as will be described in due course. After 10 rods have been tested for RTD and diameter the average weight of the 10 rods is determined at 40 and the result transmitted to and displayed at the controller 36. The 10 rods are then ejected (at 42) and discarded.

Where the measurements approach reject values an alarm signal is generated (at 43) and sent to a display terminal 44 and/or an alarm 46. In the extreme case the system controller may generate a stop signal (at 47) which can halt temporarily the manufacturing process if one or more of the parameters is not responding to control or the deviation from the prescribed value exceeds a predetermined level.

The system controller also derives diagnostic reports of performances over a shift which may be transmitted to a host computer 48 for processing.

The sampling structure can, of course, be changed by the process manager who may also vary the specification of the filter, for example to change to filters for cigarettes of a smaller diameter. The number of rods per mean sample may also be changed.

The system processor compares the mean RTD and Diameter Measurements with stored values. A target is specified and four bands specified either side of the target value as is shown in table 1 below.

4. REJECTION OF RODS + MACHINE STOP	
3. AUTOMATIC CORRECTION + ALARM	
2. AUTOMATIC CORRECTION	
1. NO ACTION	
	TARGET
1. NO ACTION	
2. AUTOMATIC CORRECTION	
3. AUTOMATIC CORRECTION + ALARM	
4. REJECTION OF RODS + MACHINE STOP	

TABLE I

If the mean falls within band 1 then it is considered acceptable and no corrective action is taken. If it falls within band 2 then corrective action is taken as will be described. Corrective action is also taken if the value is in band 3 but an alarm signal is generated in addition. If the mean is in band 4 the condition is considered unacceptable and a machine stop signal is generated.

The individual memory areas 1 to 4 are determined statisticaly for each filter specification.

Table II shows the sytem of priorities which is ascribed to the RTD and diameter control. DIAMETER HIGH (2) RTD HIGH (2) = CORRECT RTD
DIAMETER VERY HIGH (3) RTD VERY HIGH (3) = CORRECT RTD
DIAMETER LOW (2) RTD LOW (2) = CORRECT RTD
DIAMETER VERY LOW (3) RTD VERY LOW (3) = CORRECT RTD
DIAMETER HIGH (2) RTD LOW (2) = CORRECT DIAMETER
DIAMETER VERY HIGH (3) RTD VERY LOW (3) = CORRECT DIAMETER
DIAMETER LOW (2) RTD HIGH (2) = CORRECT DIAMETER
DIAMETER VERY LOW (3) RTD VERY HIGH (3) = CORRECT DIAMETER

DIAMETER HIGH (2) RTD OK (1) = CORRECT DIAMETER
DIAMETER VERY HIGH (3) RTD OK (1) = CORRECT DIAMETER
DIAMETER LOW (2) RTD OK (1) = CORRECT DIAMETER
DIAMETER VERY LOW (3) RTD OK (1) = CORRECT DIAMETER
DIAMETER OK (1) RTD HIGH (2) = CORRECT RTD
DIAMETER OK (1) RTD VERY HIGH (2) = CORRECT RTD
DIAMETER OK (1) RTD VERY HIGH (3) = CORRECT RTD
DIAMETER OK (1) RTD LOW (2) = CORRECT RTD
DIAMETER OK (1) RTD VERY LOW (3) = CORRECT RTD
DIAMETER VERY HIGH (3) RTD HIGH (2) = CORRECT RTD AND DIAMETER
DIAMETER VERY HIGH (3) RTD VERY HIGH (3) = CORRECT RTD AND DIAMETER
DIAMETER HIGH (2) RTD VERY HIGH (3) = CORRECT RTD AND DIAMETER
DIAMETER VERY HIGH (3) RTD VERY HIGH (3) = CORRECT RTD AND DIAMTER

TABLE II

In table II the numbers in brackets refer to the memory areas of table I.

Rather than correcting to the target value itself, the system processor 36 ensures that corrections are made to bring the diameter and RTD into the allowable ranges; that is the somewhere within area 1 in table I. This method has proved to be more effective than correcting to the target value as it avoid problems of over reaction and takes into account inherent variations in the machines.

It will be appreciated that conditions in which both diameter and RTD require correction can be corrected in two stages. Consider the case where both parameters are high, falling within area 2. After the mean of 5 samples has been calculated the RTD will be corrected. After five further samples the mean RTD should fall within area 1. The system will then check if the diameter requires correction. This will not always be necessary as RTD correction affects the diameter.

No feedback is associated with the weight measurement. However, the weight values are passed to the processor and compared with acceptable values. If the weight value comparison falls within an area corresponding to area 4 of table I an alarm signal is sent at 43 and the production line is stopped.

Figures 3 and 4 illustrate in more detail the pick up unit 26. Finished filter rods 50 are fed from the cut off head to a pick-up drum 52 which is a fluted drum receiving a filter in each flute. Beneath the drum is arranged a hopper 54 arranged above a pick-up shuttle 56 which is rotatable about a vertical axis 58 by means of a pneumatic actuator 60. A compressed air source is arranged to blow filters from the pick-up shuttle 56 into a pneumatic line and then towards the measurement station 28 (fig 2).

The pick-up unit operates as follows: pneumatic actuator 60 rotates the pick-up shuttle 56 through 90° about axis 58 into the position shown in Figure 3. A filter 50 is ejected from the pick-up drum and passes through hopper 54, the tapered end of which guides the filter into a channel 62 in the pick-up shuttle 56. The bracket 64 of the pick-up shuttle is then pneumatically rotated back to its starting position in which the channel of the shuttle is aligned with pneumatic line 66 (fig. 4). Compressed air from source 68 then expels the filter from the shuttle and propels it along the line 66 to the measuring station.

Filters then continue to be ejected normally into a storage container 70 (fig. 5).

The pick-up unit has the advantage of being simple, having few working parts. If a filter jams the pick-up may be reset automatically. Furthermore the unit is very compact as the pneumatic line 66 through which filters are ejected is orthogonal to the pick-up drum.

Figures 5 and 6 show the resistance to draw RTD gauge 33 (fig. 2) in greater detail, Figure 7 is an exploded view. The gauge comprises a base 72, a gauging head 74 and a sleeve 76. The gauge is connected to an actuator 78 which can rotate the head through 180° between the positions shown in Figures 5 and 6. In addition the gauge head is provided with a vacuum inlet 80, an air flow inlet 82 and an air flow outlet 84. The base 72 is provided with a rejection air flow inlet 86 and a further inlet 88 for an air jet to position the filter within the gauge.

Before a filter 90 is expelled from the decelerator 30 (fig. 2) a vacuum is created through port 80 between seals 81, 83 (fig. 7), the sleeve 76 and the gauging head 74. When a filter is dropped into the gauging head a jet of air is passed through port 88 to position the filter correctly in the head. The vacuum is then released. When the filter is within the sleeve 76, air is blown through port 82 at a constant speed (17.S ml/sec). The pressure drop is measured through port 84 by means of a transducer (not shown); an RTD value is calculated from this pressure drop and transmitted to the system processor. The gauging head is

then rotated to the position shown in Figure 6 and the head is unsealed by operating the vacuum through port 80. Air is then blown in through port 86 to eject the filter 90 towards the tape gauge where the diameter of the filter is measured.

Claims

1. A method of controlling the manufacture of cigarette filters, comprising periodically removing a completed filter from a production line, and characterised by measuring at least two variable parameters of the filter, comparing each of the measured parameters with a respective predetermined target, and adjusting the operating conditions affecting at least one parameter in response to the comparison if one or both are outside their respective targets, in accordance with a predetermined set of priorities dependent upon which parameter is outside the target and the degree and sense of each excursion from the target.
2. A method according to claim 1, characterised in that the target for each parameter is a range of acceptable values around a target value and the adjustment of the operating conditions causes one of the parameters to move into the acceptable range.
3. A method according to claim 2, characterised in that the adjustment made aims to correct the parameter to bring it to the limit of the acceptable range.
4. A method according to claim 1, 2 or 3, characterised in that the parameters are measured for a plurality of filters and the adjustments made are determined by the mean values of the parameters.
5. A method according to claim 1, 2, 3 or 4 characterised in that the excursion from the target are divided into at least two bands, one parameter being corrected for if both parameters fall outside their targets within a first excursion band, both parameters being corrected for if one of the parameters falls within a second excursion band more distant from the target than the first band and the other parameter falls within the first excursion band.
6. A method according to any preceding claim characterised in that the parameters measured are the diameter and the resistance to draw (RTD) of the filter.
7. A method according to claim 5 and 6 characterised in that the diameter and RTD are corrected either at the same time or in accordance with a preset hierarchy of priorities.
8. A method according to claim 5, 6 or 7, characterised in that an alarm signal is generated if either parameter is in the second excursion band.
9. A method according to any of claims 5 to 8 characterised in that a third excursion band is defined and the production line is stopped if either parameter falls within the third excursion band.
10. Apparatus for controlling the manufacture of cigarette filters, comprising means (26) for periodically removing for testing a filter from the production line, and characterised by means (33, 34, 40) for measuring at least two variable parameters of the filter, means (36) for comparing each of the measured parameters with respective predetermined targets, and means (36, 22, 24) for adjusting at least one parameter if one or more comparisons are not acceptable in accordance with a predetermined set of priorities dependent upon which parameter is outside its target and the degree and sense of each excursion from the target.
11. Apparatus according to claim 10, characterised in that the adjustment means (36, 22, 24) comprises means for adjusting each parameter to a value just within a range of values around the target value.
12. Apparatus according to claim 10 or 11, characterised in that the filter removal means (26) comprises means for ejecting a filter from a drum (52) holding filters (50) from the production line, means for guiding the ejected filter into a shuttle (56) and means for rotating the shuttle between a first position in which it can receive filters from the filter drum, and a second position in which a received filter can be ejected by compressed gas to a delivery tube (66), the filters in the second position being orthogonal to the filters on the drum.
13. Apparatus according to any of claims 10 to 12, characterised in that the measuring means comprises means (33) for measuring the resistance to draw of a filter, the means comprising a gauge including a gauge head (74) having air inlet and outlet ports(80, 82, 84), means (76) arranged within the gauging head for receiving a filter to be tested, the filter receiving means (76) having corresponding ports allowing passage of air from the gauging head ports across a filter inserted in the receiving means, and a base portion (72) having a port (86) communicating with the receiving means for the passage of gas into the receiving means to assist the ejection of filters from the receiving means, and means (78) for inverting the gauge for ejection of a filter.
14. Apparatus according to claim 13 characterised by means for measuring the pressure drop at the exit port to determine the resistance to draw of a filter.
15. Apparatus for conveying cigarette filters from a production line to a remote location comprising a shuttle

(56), a hopper (54) arranged to receive a filter (50) ejected from a drum reservoir (52) holding filters from the production line and to guide the filter to the shuttle, means (58, 60) for rotating the shuttle between a first position in which it can receive filters from the reservoir, and a second position in which a received filter can be ejected by compressed gas to a tube (66) for delivery to the remote location, characterised in that the filters in the second position are orthogonal to the filters in the reservoir.

16. Apparatus for measuring the resistance to draw of a cigarette filter characterised by a gauging (74) head having a gas inlet and a gas outlet (80, 82, 84), means (76) for receiving a filter arranged within the gauging head and having corresponding apertures for inlet and outlet of gas allowing passage of gas across a filter inserted in the receving means, a base portion (72) having a port (86) communicating with the receiving means for the passage of gas to assist the ejection of filters from the receiving means, and means (78) for inverting the gauging head and the receiving means for filter ejection.

17. Apparatus according to claim 16, characterised by a further gas port (88) in the base portion for admittance of a gas jet to position correctly the filter in the filter receiving means.

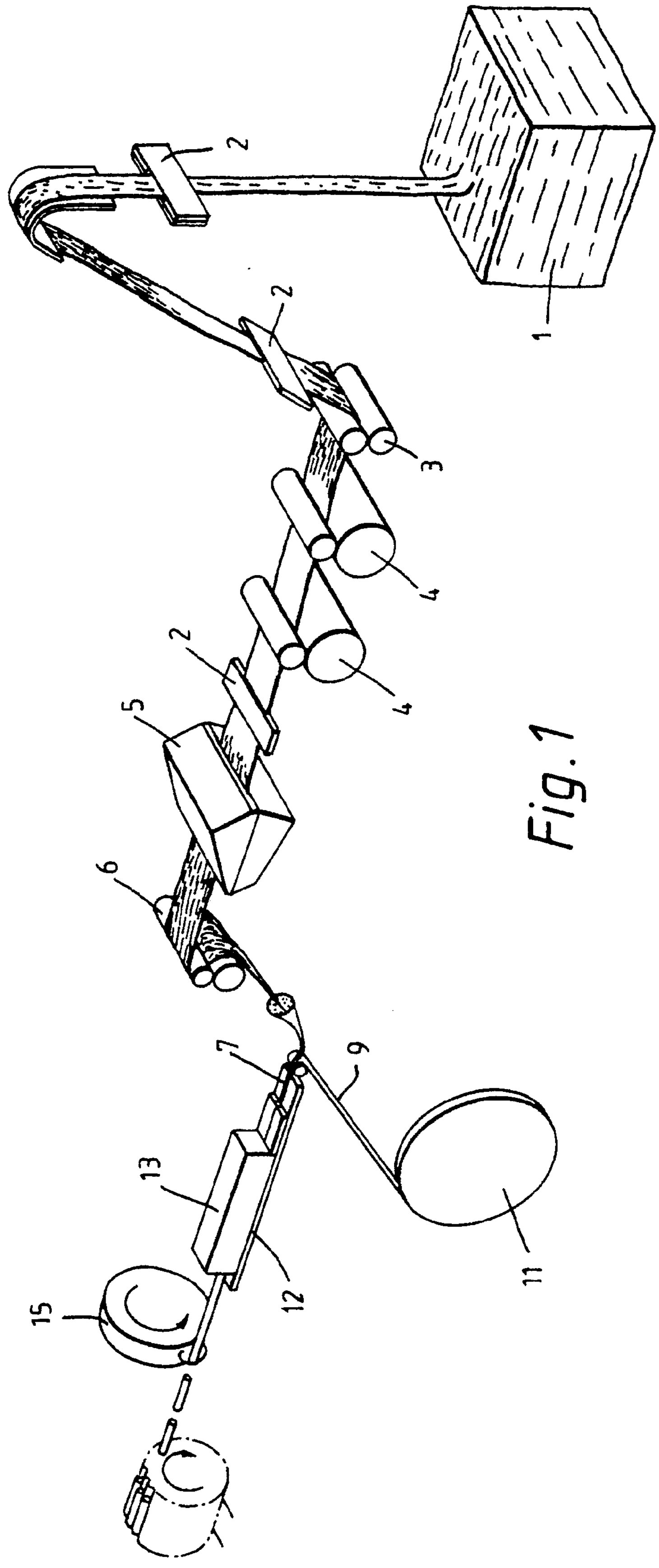

Fig. 1

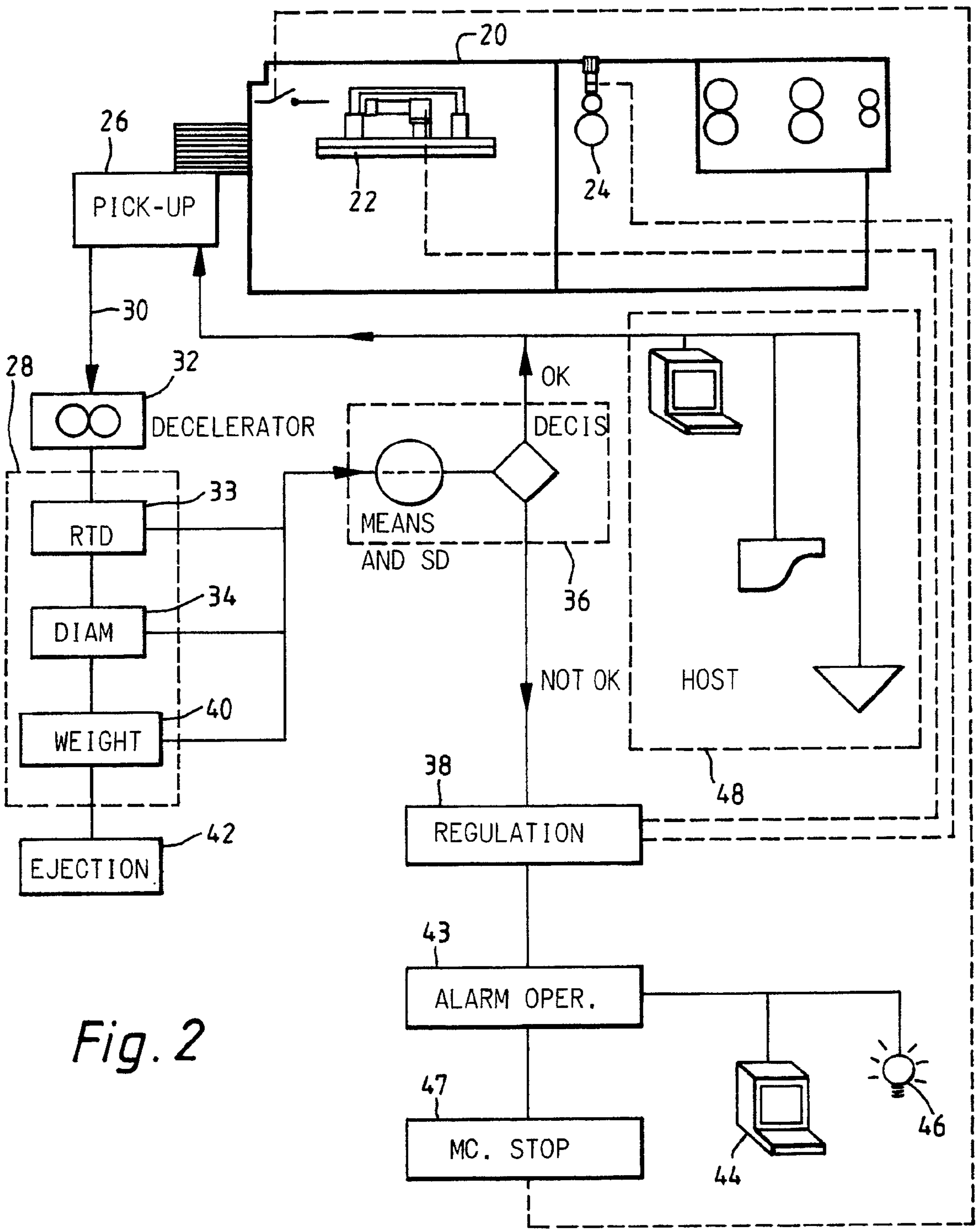
20
26
PICK-UP
22
24
30
28
32
DECELERATOR
OK
DECIS
33
RTD
MEANS
AND SD
34
DIAM
36
NOT OK
HOST
40
WEIGHT
48
38
REGULATION
42
EJECTION
43
ALARM OPER.
47
MC. STOP
46
44

Fig. 2

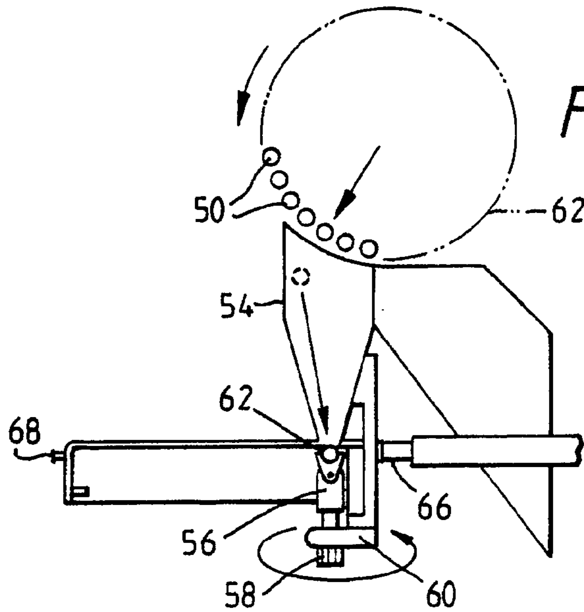

Fig.3

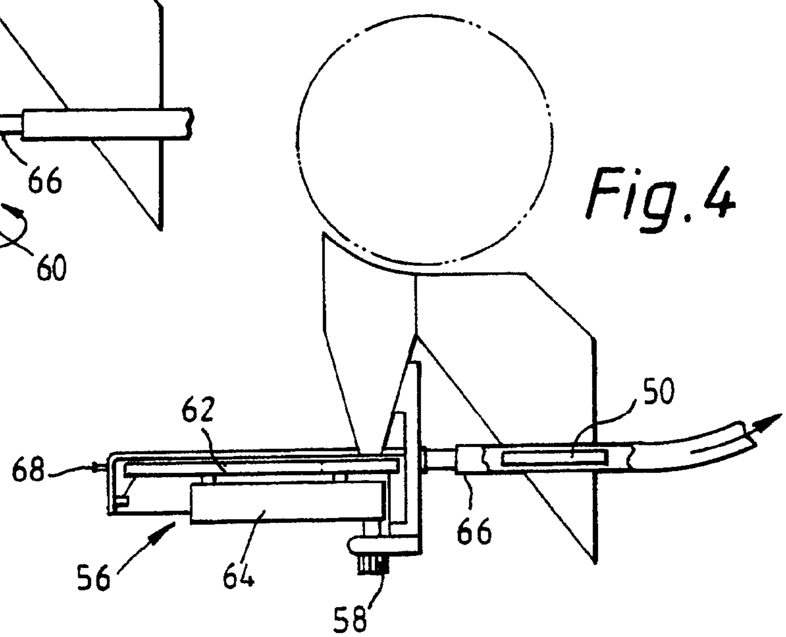

Fig.4

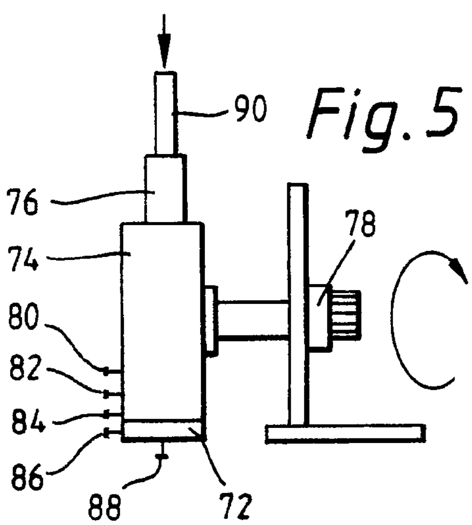

Fig.5

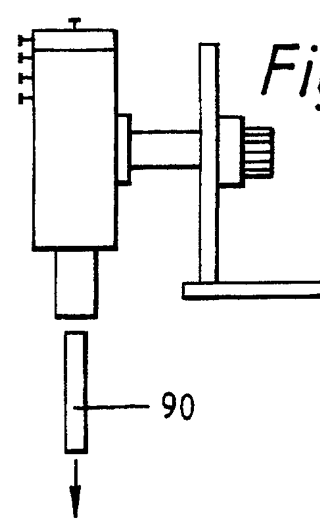

Fig.6

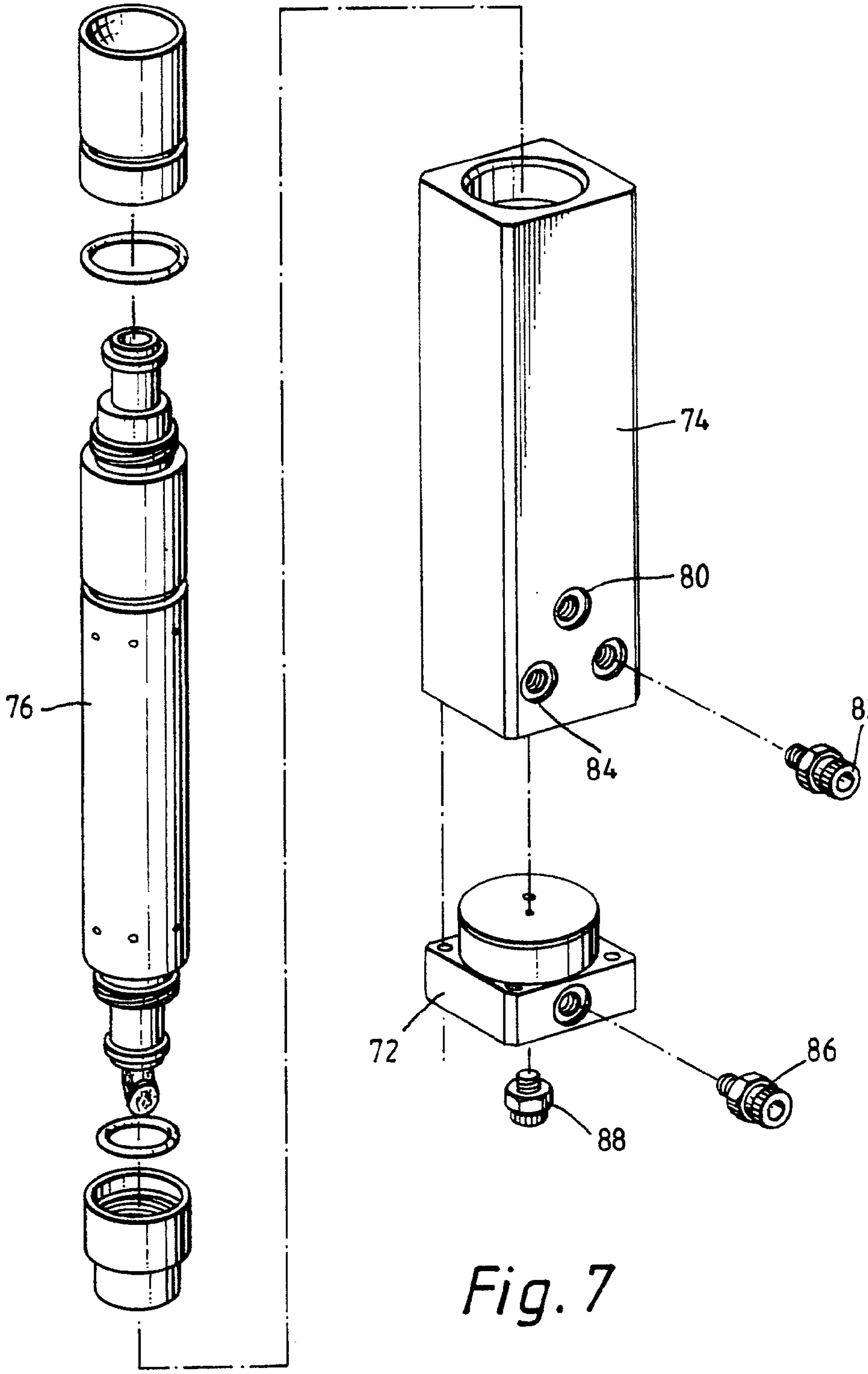

Fig. 7